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ABSTRACT. Using data from a survey of 1,097 small and medium-sized non-listed Dutch firms we investigate the relation between growth of the firm and uncertainty. We focus on the impact of sales uncertainty on various types of investment. We find that sales uncertainty, measured by the conditional variance, has a mixed impact on various investment decisions. We include an analysis of the relevance of financial structure and firm size on the growth-uncertainty relation.

KEY WORDS: firm size, uncertainty, gibrats law, firm investment. JEL CLASSIFICATION: D21, D82, D92, E22.

1. Introduction

How does uncertainty affect growth of the firm? The interest for the impact of uncertainty is raised by recent advances in the literature on the investment-uncertainty relation (see Dixit and Pindyck, 1994). Uncertainty can lead to an increase of investment activity if managers are risk neutral and firms operate in perfect competitive markets. On the other hand with risk aversion and market power it is likely that uncertainty hampers growth. The sign of the investment-uncertainty relation has attracted both theoretical and empirical attention in the last decades. Whereas the sign is ambiguous from a theoretical point of view, most empirical studies provide support for a negative effect of uncertainty on investment (see for instance Aizenman and Marion, 1993; Bell and Campa, 1997; Caballero and Pindyck, 1996; Ferderer, 1993a, b; Leahy and Whited, 1996; Pattillo, 1998; Pindyck, 1986; Pindyck and Solimano, 1993; and Price, 1996).

Most studies use historical data to proxy future uncertainty. However, it is likely that an ex post measure of uncertainty does not reflect entrepreneurs' subjective perception of risk. To come around this problem, Guiso and Parigi (1999) proposed to proxy the firms' risk perception using results of an interview study. Managers of firms are asked for their subjective ideas on the variability of future demand for their products. Pattillo (1998) uses a similar strategy in her study on the investment-uncertainty relationship for Ghana. In this paper we follow a similar approach for Dutch firms. More specifically, we interviewed Dutch firms about their investment plans, their expectations regarding future sales, the financial position, etc. in order to investigate whether uncertainty has a positive or negative effect on firm growth in general and investment in particular. We approximate growth of the firm by various types of investment. Moreover, we have information on the financial positions of the firms (measured by variables like solvability, current Return on Assets (ROA), and demand for external financing). This implies that we can test the hypothesis that financial imperfections have an impact on the investment-uncertainty relationship.

We start in Section 2 with a short survey of the literature on investment and uncertainty. Section 3 explains the interview study, including the measurement of indicators of uncertainty. The survey contains 1,100 records of firms on the plant level. We include firms of various sizes. The majority of the firms have less than 100 employees, which indicates that we address a small firm's growth decision. The survey was carried out in 1999. Section 4 presents the main estimation results. Section 5 analyses the special

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cases of the impact of financial structure and firm size. Section 6 summarizes and concludes.

2. The impact of uncertainty

The investment decision is mostly taken under genuine uncertainty. Some economists believe that the investor is tortured by fundamental uncertainty (Knight, 1921), which implies that the investor is not able even to give a subjective probability function of all possible outcomes. This might easily lead to the well-known Keynesian animal spirits in investment. For modelling purposes the Knightian uncertainty is killing though, so we abstract from fundamental uncertainty. Here we do assume that the investor is able to formulate a density function of all outcomes, which implies that the investor can analyse future prospects of the investment project.

The literature is ambiguous about the sign of the investment-uncertainty relationship. The following characteristics influence the sign:

1. The degree of product market competition. If an entrepreneur faces perfect competition there is a greater likelihood that uncertainty will affect investment positively (Abel, 1983; and Hartman, 1972).
2. The degree of returns to scale. Caballero (1991) argues that the positive correlation between investment and uncertainty based on the Hartman-Abel prediction is traceable to the assumptions of perfect competition and constant returns to scale. However, with increasing returns to scale the entrepreneur will dislike uncertainty more, since there are decreasing marginal costs.
3. The degree of risk aversion. Risk loving entrepreneurs will react positively on more uncertainty, whereas risk-averse entrepreneurs react negatively to more uncertainty (Nickell, 1978).
4. Irreversibility of investment. An investor who faces high costs of reverting investment will probably not invest and wait until more information is revealed to the market (Dixit and Pindyck, 1994).
5. The possibilities to obtain external credit. The probability of a negative investment-uncertainty relationship increases the more a firm is financially constrained (Ghosal and Loungani, 1997). A risk-averse creditor (see also the third argument) will be more reluctant to supply credit in times of large uncertainty.

The modern theory of investment under uncertainty emphasises costly reversibility of investment. The irreversibility property of investment is relevant to explaining investment behaviour only when investment decisions are made under uncertainty. Within the framework of irreversibility investment opportunities are seen as call options on real assets. The firm has the right but not the obligation to buy the sequence of cash flows that are generated by the investment project in the future by paying a certain amount of investment costs. The key assumptions of the real option approach to investment behaviour are the existence of irreversibility and the possibility to delay investment. If investment decisions are irreversible, investment will be more sensitive to uncertainty facing the firm. Since the firm that has more irreversible capital has a higher opportunity cost of capital (including the option value of investing right now), the firm will require a higher marginal revenue product of capital to match the trigger of investment. Therefore waiting is highly demanded to obtain new information. Consequently, uncertainty directly affects the threshold that triggers the occurrence of investment through which it affects the timing decision of investment and hence the scale of investment at a specific point in time (Bernanke, 1983; McDonald and Siegel, 1986; Pindyck, 1991; Dixit and Pindyck, 1994). It should be noted here that although uncertainty probably increases the threshold to trigger investment, a firm might invest more than it would do in a certain environment once the trigger is reached. If there are mainly fixed costs to adding capacity it might be worthwhile to over-invest in capacity holding valuable operating options. So uncertainty affects both the trigger and (once the trigger has been pulled) it might have an impact on the size of the investment. Moreover, as Sarkar (2000) shows, an increase in uncertainty also increases the probability to hit the trigger. So it is worthwhile to investigate the decision to invest (or not) and the decision how much to invest.

3. The survey

This paper uses data from an annual survey among a panel of Dutch firms. The survey is carried out by the Department of Spatial Sciences of the University of Groningen. In the 1999 edition of this survey we added a number of questions on investment, employment growth, and expected uncertainty. The main topic of the survey is the analysis of location strategies. The survey was mailed to 1,967 panel members, of which 903 (45.9%) responded. In order to compensate for the "death" of panel members, unwillingness to continue panel participation, and retirement or job change of the contact person, another 2,695 firms were mailed in a second round of the survey. The latter resulted in 197 questionnaire forms or a response rate of 7.3%, which is more in line with response rates that are generally observed in written questionnaires amongst private firms. Due to missing values not all of the 1,100 observations are useful. The question on sales expectations, a crucial item for our paper, had a response rate of 85%.

It is good to note that data are collected on the level of individual firm establishments as opposed to the company or other organisational level. This makes this survey valuable for the analysis of investment, because the plant manager is most likely responsible for the investment decisions. The sectors strongly represented in the research group include industry (29%) and business services (22%), followed by wholesale (17%) and construction (15%). Smaller segments include retail and restaurants (10%) and transport and communication (6%). Agricultural business and government agencies are not included. Moreover, the survey includes only a relative small number, 5%, of very small firms (less than 5 employees).

Table I presents descriptive statistics on the key variables of our analysis. We include investment data, financial structure indicators, and information concerning profitability (in terms of return on assets) and problems in attracting external finance.

TABLE I
Descriptive statistics

	Mean	Median	σ	*n*
Total investment/Sales	8.462	3.102	18.245	766
Investment in buildings/Sales	4.126	0.000	19.838	763
Investment in fixed assets/Sales	4.881	2.174	8.378	763
Replacement investment	57.436	60.000	32.025	934
Expansion investment	41.729	40.000	31.792	934
Solvability (%)	40.587	35.000	26.726	761
External finance (%)	77.229	80.000	23.949	245
Expected return on assets (%)	25.374	15.000	28.102	546
Size (employees in 1999)	102.06	35.000	318.57	1070
Sales (million guilders)	58.463	11.000	382.89	846

Mean and median values in percentages (except for sales), σ = standard deviation, *n* = number of observations. All Total investment/Sales observations are positive.

Size (% number of employees in 1999, *n* = 1070)
- ≤ 10 11.21
- ≤ 25 40.84
- ≤ 50 63.64
- ≤ 100 83.46

Current profitability (%, *n* = 1064)
- too low 19.27
- reasonable 31.95
- good 42.86
- not applicable 5.92

Problems in getting external finance (%, *n* = 271)
- many 2.21
- some 6.27
- indifferent 19.56
- a few 38.75
- very few 33.21

We note that there is a significant negative correlation between solvability and external financing (partial correlation coefficient is –0.25, which is significant for this sample size at the 95% confidence interval).

Next we turn to measuring uncertainty. In line with Guiso and Parigi (1999) and Pattillo (1998) we have asked entrepreneurs about their expected sales in 2002 vis-à-vis sales in 1998. For each expected change in sales presented in Table II entrepreneurs are requested to provide the likelihood of the change on a scale of 0–100. Hence, firms give a density forecast of expected sales. The answers to this question are used to proxy the conditional mean and variance of the growth rate of sales 3 years ahead. In order to do that, we assume that the central values of the open intervals more than 20% and less than 20% are 50 and 30 percent, respectively. The distribution is assumed to be uniform within the intervals.

The conditional mean (*CMEAN*) and the conditional variance (*CVAR*) are measured by:

$$CMEAN = (1 + d^e)S_0 \quad (1)$$

$$CVAR = var^e\ (S_0)^2 \quad (2)$$

S_0 are sales (in guilders) in the base year (1998), and d^e and var^e are the expected mean and variance of the growth rate of sales computed from the answers given in Table II.

The coefficient of variation of expected sales (*COEFV*) is a proxy for uncertainty. It is defined as the standard deviation divided by the mean of the distribution: $COEFV = \sqrt{CVAR/CMEAN}$. It is good to note that relative sales growth (defined by *CMEAN* minus the actual 1998 sales over the 1998 sales) is positively correlated (0.26) with the measure of the mean of uncertainty *COEFV*. It is quite commonly assumed that an increase in uncertainty implies a mean-preserving spread in uncertainty (which is not completely true in our sample, given the previous statement). Table III gives a frequency distribution of *COEFV* for all firms that have completed the questionnaire. Note that 167 firms reported no uncertainty: we will treat these cases with special care hereafter. In the remainder of this paper we will use the *COEFV* as well as the ratio of the conditional variance and the conditional mean *CVAR*/*CMEAN*. We label this ratio *COEFV2*. Table III gives the descriptive statistics for the uncertainty variables. As can be seen by comparing the mean and the median, the

TABLE II
Subjective density of expected growth of sales

Sales development 1998–2002	Probability
Increase of more than 20%	
Increase of 15%–20%	
Increase of 10%–15%	
Increase of 5%–10%	
Increase of 0%–5%	
Decrease of 0%–5%	
Decrease of 5%–10%	
Decrease of 10%–15%	
Decrease of 15%–20%	
Decrease of more than 20%	
Total amount of points	100

TABLE III
Conditional mean and variance of sales

The conditional mean (*CMEAN*) and the conditional variance (*CVAR*) of sales are measured by:

$CMEAN = (1 + d^e)S_0$

$CVAR = var^e\ (S_0)^2$

S_0 are sales in the base year (1998), and d^e and var^e are the expected mean and variance of the growth rate of sales computed from the answers given in Table II. *COEFV* is defined as the standard deviation divided by the mean of the distribution: $COEFV = \sqrt{CVAR/CMEAN}$. *COEFV2* = *CVAR*/*CMEAN*. *CMEAN*, *CVAR* in million guilders, *COEFV* and *COEFV2* in percentages. The number of observations is 842.

Frequency distribution

Interval	Number of firms	Frequency
0	167	19.8
0 < *COEFV* < 0.1	179	21.3
0.1 < *COEFV* < 0.2	93	11.0
0.2 < *COEFV* < 0.5	64	7.6
0.5 < *COEFV* < 1	63	7.5
1 < *COEFV* < 1.5	94	11.2
1.5 < *COEFV* < 2	61	7.2
COEFV > 2	121	14.4
Total	842	100

Descriptive statistics

	Mean	Median	σ
CMEAN	68.079	12.485	459
CVAR	6.76E+5	6.32E+5	1.84E+7
COEFV	0.767	0.166	1.031
COEFV2	127	0.477	1590

distribution of all uncertainty variables is skewed. In the next section we relate the investment decisions of the firms with the uncertainty measures.

4. Model specification and estimation results

In this section we present models that relate investment of the firm to measures of uncertainty. We include two types of models. First we estimate investment choice models: what is the probability that the firm invests at all? Secondly, we present models that explain the level of investment, if the firm invests. These two approaches can lead to conflicting results. It might be so that firms are stimulated to invest, but at a lower level, if uncertainty is prominent. So including both models enhances our understanding of growth decisions.

The literature offers a wide range of investment models. The majority of these models cannot be used though, because our survey does not include balance sheet information. This excludes for instance the use of Tobin's Q. Moreover we have no information on the dynamics of investment (no information on adjustment costs), which seriously limits our class of applicable models. We therefore estimate a simple reduced-form accelerator type of investment model including an uncertainty term. The expected growth rate of sales represents future profitability of the firm. The probit-model is specified as follows:

$$\text{Prob}(INVi = 1) = a_1\, DSAL/SAL + a_2\, UNC + a_3 \tag{3}$$

where *INVi* is the ratio between a certain measure *i* of investment. We include four definitions of investment:

1) *INV1* refers to the total value of investment;
2) *INV2* refers to investment in buildings;
3) *INV3* refers to investment in fixed assets;
4) *INV4* refers to the largest investment project of the firm.

Prob(*INVi* = 1) represents the probability of positive investment of type *i*. *DSAL* is the change in sales (measured as the conditional mean of sales, *CMEAN*, minus the 1998 value of sales *SAL*). *UNC* is the uncertainty proxy.

In Table IV we present the estimation results for model (3). We include two panels: Panel A for the *COEFV* and Panel B for the *COEFV2*-measure of uncertainty. Moreover we include two sets of results in each panel. In the upper lines we exclude the cases for which the firm reports no uncertainty (see Table III: 167 firms report no uncertainty), in the lower lines we include the zero-uncertainty cases. Panel A demonstrates a slight positive impact of *COEFV* on the decision to invest in a large project (*INV4*) in the model where we exclude the zero-uncertainty case. If we include the zero-uncertainty observations we find a significant positive impact of uncertainty in general. This implies that the firms that report no uncertainty are less eager to invest. Panel B only shows a significant positive sign for the investment in buildings (the other results being insignificant). So our main conclusion from the probit regressions is that if there is an impact of uncertainty on the decision to invest or not it is a positive one (experimenting with a logit specification gave similar results). In general, as Sarkar (2000) shows, an increase in uncertainty increases the probability of hitting the threshold (which itself depends on uncertainty), which would stimulate investment to a certain extent. To summarise, the results of the probit-estimation in general seem to provide some support for a positive sign of the decision to invest-uncertainty relationship.

Next we turn to the size of the investment project undertaken. For positive investment decisions we model:

$$INVi/SALES = a_1\, DSAL/SAL + a_2\, UNC + a_3 \tag{4}$$

where $i = 1, \ldots, 4$ and *INV1* = total value of investment; *INV2* = total investment in buildings; *INV3* = investment in machinery; *INV4* = largest investment project; *DSAL* = *CMEAN*-sales in 1998 (*SAL*), and *UNC* is the uncertainty measure. Model (2) is the continuous version of the discrete choice model (1). Table V presents the results for the size of investment of firms that do invest. We exclude extreme observations by assuming that $INVi/SALES < 0.5$, for $i = 1, \ldots, 4$. We again present the results for the models including positive observations for the uncertainty proxy only (excluding the 167 observations with *COEFV* = 0 from Table III) in the upper half of Panels A and B, and results for models that include the zero-uncertainty cases in the lower part of both panels. We again include the indicators of

TABLE IV
Investment under uncertainty: Probit specification

The model estimated reads:

$$\text{Prob}(INVi = 1) = a_1\ DSAL/SAL + a_2\ UNC + a_3$$

where $i = 1, \ldots, 4$ and *UNC* is the uncertainty measure. *INV1* = total value of investment; *INV2* = total investment in buildings; *INV3* = investment in fixed assets; *INV4* = largest investment project; *DSAL* = *CMEAN*-sales in 1998 (*SAL*), *LL* is the loglikelihood. Sales uncertainty is measured by *COEFV* (Panel A) and *COEFV2*: the conditional variance (Panel B). We report results for *COEFV2* > 0 in the upper half of the panel; in the lower part we include the *COEFV* = 0 and *COEFV2* = 0 observations as well (uncertainty variables indicated by *COEFV0* and *COEFV20* respectively). Standard errors are within parentheses.

Panel A – Sales uncertainty measured by *COEFV*

	INV1	*INV2*	*INV3*	*INV4*
DSAL/SAL	0.852	0.872	0.797	0.458
	(0.651)	(0.418)	(0.552)	(0.500)
COEFV	0.061	0.077	0.067	0.104
	(0.073)	(0.053)	(0.072)	(0.068)
Intercept	1.143	–0.248	1.110	0.900
	(0.096)	(0.077)	(0.095)	(0.086)
LL	–211.35	–422.01	–220.15	–278.44
# *INVi* = 0	65	321	69	99
# observations	675	618	675	675
DSAL/SAL	0.442	0.661	–0.013	0.186
	(0.371)	(0.295)	(0.347)	(0.330)
COEFV0	0.115	0.097	0.158	0.150
	(0.065)	(0.046)	(0.064)	(0.059)
Intercept	1.109	–0.248	1.083	0.863
	(0.081)	(0.067)	(0.080)	(0.074)
LL	–281.02	–520.36	–301.41	–366.35
# *INVi* = 0	89	402	99	135
# observations	842	762	842	842

Panel B – Sales uncertainty measured by *COEFV2*

	INV1	*INV2*	*INV3*	*INV4*
DSAL/SAL	1.113	0.980	1.070	0.861
	(0.515)	(0.380)	(0.505)	(0.448)
*COEFV2**E-10	–0.675	3.898	–0.593	–0.557
	(0.496)	(1.822)	(0.413)	(0.428)
Intercept	1.177	–0.224	1.146	0.949
	(0.090)	(0.073)	(0.089)	(0.082)
LL	–209.53	–420.27	–218.71	–278.11
# *INVi* = 0	65	321	69	99
# observations	675	618	675	675
DSAL/SAL	0.636	0.737	0.207	0.434
	(0.365)	(0.287)	(0.341)	(0.323)
*COEFV20**E-10	–0.608	4.368	–0.511	–0.495
	(0.441)	(1.835)	(0.373)	(0.390)
Intercept	1.170	–0.214	1.165	0.937
	(0.076)	(0.063)	(0.075)	(0.069)
LL	–280.80	–519.13	–220.15	–368.51
# *INVi* = 0	89	402	99	135
# observations	842	762	842	842

TABLE V
Investment under uncertainty: Size of investment

The model estimated reads:

$$INVi/SALES = a_1\ DSAL/SAL + a_2\ UNC + a_3$$

where $i = 1, \ldots, 4$ and *INV1* = total value of investment; *INV2* = total investment in buildings; *INV3* = investment in fixed assets; *INV4* = largest investment project; *DSAL* = *CMEAN*-sales in 1998 (*SAL*), *UNC* is the uncertainty measure, *F* is the *F*-value, R^2 is the adjusted determination coefficient. White-consistent standard errors are in parentheses. The sample is restricted to *INVi/SALES* < 0.5, *INVi* > 0, and *COEFV2* > 0. In the upper half of the panels we report the results for *COEFV2* > 0. In the lower parts we include comparable results for uncertainty measures that include *COEFV* = 0 and *COEFV2* = 0 cases (*COEFV0* and *COEFV20* denote the uncertainty measures respectively). Standard errors are within parentheses.

Panel A – Sales uncertainty measured by *COEFV*

	INV1	INV2	INV3	INV4
DSAL/SAL	0.060	0.044	0.040	0.062
	(0.029)	(0.042)	(0.023)	(0.025)
COEFV	–0.000	0.003	–0.001	0.000
	(0.004)	(0.004)	(0.003)	(0.003)
Intercept	0.052	0.035	0.039	0.032
	(0.005)	(0.006)	(0.004)	(0.003)
R^2	0.007	0.003	0.004	0.015
F	2.986	1.502	2.056	5.296
# observations	592	289	601	562
DSAL/SAL	0.079	0.071	0.039	0.071
	(0.022)	(0.035)	(0.017)	(0.020)
COEFV0	–0.003	–0.002	–0.002	–0.003
	(0.003)	(0.005)	(0.003)	(0.003)
Intercept	0.054	0.041	0.041	0.036
	(0.041)	(0.006)	(0.004)	(0.003)
R^2	0.018	0.009	0.006	0.022
F	7.691	2.576	3.054	8.636
# observations	731	351	735	690

Panel B – Sales uncertainty measured by *COEFV2*

	INV1	INV2	INV3	INV4
DSAL/SAL	0.072	0.067	0.048	0.070
	(0.026)	(0.040)	(0.020)	(0.021)
*COEFV2**E-10	–0.275	–0.215	–0.216	–0.140
	(0.061)	(0.063)	(0.048)	(0.067)
Intercept	0.053	0.038	0.039	0.032
	(0.004)	(0.006)	(0.003)	(0.003)
R^2	0.021	0.016	0.018	0.022
F	7.490	3.408	6.585	7.165
# observations	592	289	601	562
DSAL/SAL	0.081	0.072	0.042	0.071
	(0.021)	(0.033)	(0.016)	(0.018)
*COEFV20**E-10	–0.296	–0.244	–0.220	–0.163
	(0.064)	(0.068)	(0.047)	(0.069)
Intercept	0.054	0.041	0.041	0.036
	(0.004)	(0.006)	(0.003)	(0.003)
R^2	0.029	0.021	0.017	0.062
F	11.994	4.734	7.205	11.041
# observations	731	351	735	690

sales uncertainty: the coefficient of variation (*COEFV*) and the conditional variance over the conditional mean (*COEFV2*). All variables are scaled by sales to avoid heteroskedasticity (moreover we use the White-corrected standard errors).

What can be concluded from Table V? First we note that the uncertainty variable defined by the conditional variance over the conditional mean performs by far better than the coefficient of variation (the latter is not significant in any regression). Secondly, the accelerator model is relevant in all models with *COEFV2*. The fit of the Panel B-models is better than the corresponding models in Panel A. Thirdly, the disaggregation of the equation for total investment into separate equations for investment in buildings and investment in machinery does not add any new insights in Panel B (as it was the case in Table VI Panel B). And lastly, uncertainty has a negative impact on the size of investment, no matter what the type of investment is. This holds for both the results that include or exclude the zero-uncertainty observations. So Table IV illustrates a weak positive impact of uncertainty on reaching the hurdle, while Table V shows the negative impact of uncertainty on the size of investment projects. This would imply that the Sarkar-model (see Sarkar, 2000) works in explaining the hurdle-effect of uncertainty, while the more traditional explanations of the impact of uncertainty apply to the size of investment.

5. The impact of financial structure and size of the firm

In the previous section we analysed the impact of sales uncertainty on the investment decisions of the firms. The main conclusions are that more uncertainty triggers investment more, but investing firms invest less (excluding investment in buildings). In this section we analyse the role of both the financial structure and the size of the firm. It might be that firms in financial problems behave differently from healthy firms. It might also be true that small firms behave differently than bigger firms. We first discuss the financial structure, next we analyse the size effects.

TABLE VI
Financial structure of the firm

We estimate the probability that the firm invests in a large project:

$$\text{Prob}(INV4 = 1) = a_1\, DSAL/SAL + a_2\, COEFV2 + a_3$$

where *INV4* = 1 if the firm notifies a large investment. *DSAL* = *CMEAN*-sales in 1998 (*SAL*), *COEFV2* is the uncertainty measure. *LL* is the log-likelihood. Standard errors are within parentheses.

Panel A – Solvability

	Solvability < 30%	Solvability > 40%
DSAL/SAL	5.541	7.706
	(1.157)	(1.803)
COEFV2	–0.774	2.950
	(0.150)	(0.666)
LL	–131	–113
# *INV4* = 0	46	33
# observations	233	236

Panel B – Current return on assets

Here we use the answers as presented in Table II concerning current satisfaction with respect to profitability.

	Current profitability is:	
	Too low, reasonable	Good
DSAL	5.141	6.897
	(0.980)	(1.058)
COEFV2	3.300	–0.808
	(0.505)	(0.151)
LL	–245	–206
# *INV4* = 0	71	62
# observations	431	404

5.1. *Financial structure*

It is widely known that financial imperfections let investment decisions be conditional on financial structure. The most famous examples of the relevance of financial structure are the role of the debt-equity ratio in explaining either under- or over-investment, and the alleged impact of the wedge between the price of external and internal capital on investment (leading to under-investment). Concerning the former it might be so that firms with a large proportion of debt relative to equity are either restrained in their investment

through high interest obligations (under-investment) or behave strategically and over-invest (given the limited liability of debt) at the expense of debt holders. Concerning the wedge between the price of external and internal capital, it is generally believed that a higher wedge will force the firm to rely more on internal cash flow. A lack of cash flow will therefore limit investment. It is not clear ex ante how these financial conditions will influence the investment-uncertainty relationship though. But it is likely that the role of the financial structure is not neutral. Compare e.g. a firm with a high debt-to-assets ratio and a firm with a normal leverage. Both firms face uncertainty and suppliers of financial capital are risk averse (think of a bank that provides a new loan). Leverage indicates most likely financial distress for the firm with a large proportion of debt. An increase in uncertainty faced by the firm might lead to credit rationing by the bank, leading to lower investment. If the financier is risk neutral and the firm manager is risk neutral though an increase of uncertainty might lead to additional investment and risk taking (given limited liability).

We have two general indicators of financial structure available: solvability and satisfaction concerning current return on assets (see the results in Table I). Moreover for the largest investment project we know the percentage of external finance and the trouble in getting finance for about 30 percent of the firms. We therefore proceed with estimating probit equations for the largest investment project of the firm using *COEFV2* (given the previous results) and financial indicators and test for the neutrality of the investment-uncertainty relation to financial structure.

Table VI gives the results for tests of two types of neutrality:

- With respect to solvability: is low/high solvability leading to more sensitivity of investment for uncertainty (Panel A)?
- Satisfaction with current return on assets. Is low profitability (and, hence, low cash flow) affecting the investment-uncertainty relationship (Panel B)?

Given the ambiguous results from the theory of finance as sketched above it is hard to give precise one-sided hypothesis concerning the impact of financial structure variables. We therefore concentrate on the Modigliani-Miller neutrality hypothesis: financial structure does not matter. We estimate two cases (so two subgroups of firms) in all models: the "good" and the "bad" case.

For solvability we use a cut-off rate for solvability of 30 per cent on the lower bound and 40 per cent on the upper bound (median value is 35 per cent). Table VI Panel A presents the estimation results. We see that investment demand is reduced through uncertainty for low solvability firms. For high solvability firms we observe that uncertainty has a positive effect. This would confirm the idea of under-investment (possibly caused by risk aversion of management and financiers). Apparently firms with a low leverage are able to take the risk of expansion a little more. In Panel B we use the data as presented in Table I concerning the impression of the managers concerning current return on assets. The managers gave discrete answers: current profitability is either: (1) too low, (2) reasonable, or (3) good. We lump (1) and (2) into the low profitability case. Firms with high current return on assets are more likely not to invest if uncertainty increases. Firms with low profitability invest more with a higher sales uncertainty. This might point at the degree of market competition the firm faces: in competitive markets, profits will be lower and investment will increase with a higher uncertainty.

5.2. *Size*

Finally we turn to the role of size of the firm. Do smaller firms respond differently to uncertainty as compared to larger firms? If we again review our five elements of the investment-uncertainty sign explanation in Section 2 and relate these to the question of the relevance of size we can think of the following arguments. First, smaller firms are believed to operate in competitive markets, while bigger firms might exert more market power. This would imply that smaller firms are more likely to show a positive investment-uncertainty correlation. Secondly, it is likely that bigger firms invest in larger projects, which are likely to be more specialised and possibly hard to resell. So irreversibility might affect bigger firms more than smaller firms. This implies that big firms are more likely to show a negative investment-uncertainty relationship. On the other hand, in smaller firms

the probability that the owner of the firm is also the manager increases. If we assume that in these cases managerial decisions are more based on risk aversion (the manager-owner is afraid to lose his firm and job) this would imply that smaller firms would reveal a negative investment-uncertainty sign. Finally, it might be that small firms face more financial constraints (the impact of this argument on the sign of the investment-uncertainty relationship is not clear as argued in the previous subsection). Of the 271 firms that responded to the question concerning financial problems 171 firms are small firms (so 100 big firms). Small firms reported in 30 per cent of the cases financial problems, while big firms only reported in 24 per cent of the cases problems in attracting external capital.

Table VII gives the results of the probit-regressions for large and small firms. We split firms into classes based on the number of employees (less than 50 or greater or equal to 50). Table VII shows that the probability to invest decreases for small firms if sales uncertainty increases. This points at the risk aversion argument of the owner/manager of the small firm. For larger firms we find that investment is stimulated by an increase in sales uncertainty. This result is in line with the general notion that managers of bigger firms demonstrate more risk neutral behaviour. Our results do not support the idea that small firms have to operate in competitive markets or bigger firms have more irreversible investment projects (and that this element dominates the risk aversion argument).

TABLE VII
Size of the firm

We estimate the probability that the firm invests in a large project:

$$\text{Prob}(INV4 = 1) = a_1\, DSAL/SAL + a_2\, COEFV2 + a_3$$

where *INV4* = 1 if the firm notifies a large investment. *DSAL* = *CMEAN*-sales in 1998 (*SAL*), *COEFV2* is the uncertainty measure. *LL* is the log-likelihood. Standard errors are within parentheses.

	Employees (1995) < 50	Employees (1995) ≥ 50
DSAL/SAL	7.668	5.474
	(1.456)	(0.859)
COEFV2	–0.073	2.650
	(0.020)	(0.985)
LL	–136	–305
# *INV4* = 0	33	95
# observations	266	545

6. Conclusions

In this paper we analyse the relation between growth of the firm and uncertainty. A special feature of the study is that it uses data from a survey amongst a panel of 1,100 small and medium sized Dutch firms. This allows us to measure uncertainty ex ante. We approximate growth of the firm by various forms of investment. We find a couple of results. First, we find some evidence that an increase in sales uncertainty triggers the *investment decision* in a positive manner. Secondly, we conclude that uncertainty measured by the conditional variance over the conditional mean of expected sales has a significant negative impact on the *level* of investment decisions made by firm managers. The main exception here is investment in buildings, for which we find a positive impact of uncertainty on the size of investment.

Finally, we conclude that low solvability and a high current return on assets make it more likely that the firm will respond negatively in its investment decision to an increase in sales uncertainty. Smaller firms also have a lower probability to invest if uncertainty increases. For future research it is useful to get more insight into investment dynamics. This requires that we use the same survey for the analysis of future decisions of the firms. Moreover we are then able to track the forecasting ability of the managers and see whether managers show learning behaviour.

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